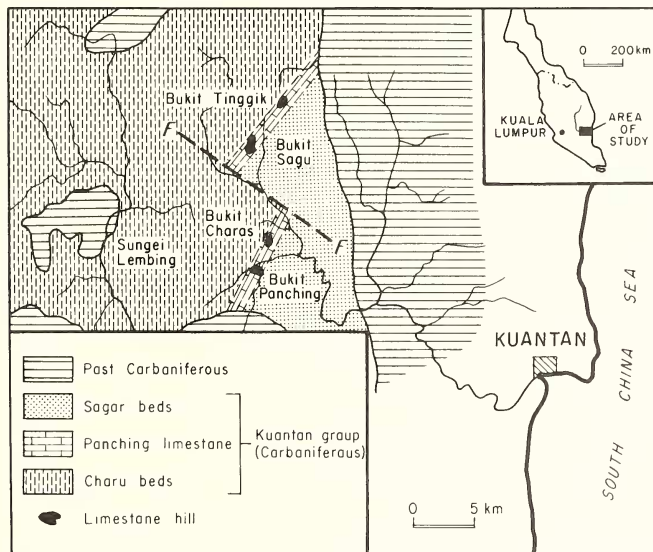


UPPER CARBONIFEROUS CONODONT FAUNAS OF THE PANCHING LIMESTONE, PAHANG, WEST MALAYSIA

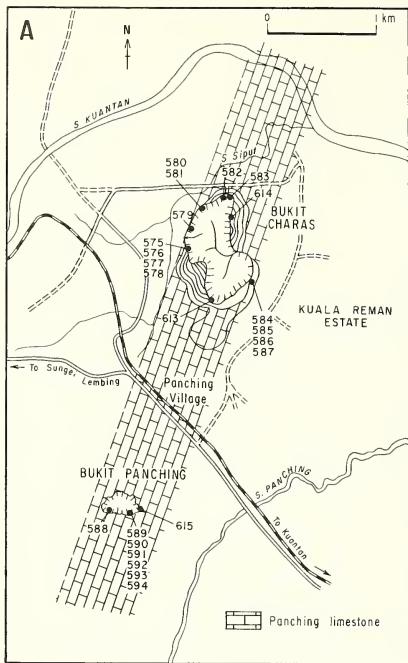
by I. METCALFE

ABSTRACT. The Panching limestone, from Pahang, West Malaysia, has yielded a rich conodont fauna which represents the *Idiognathoides noduliferus*-*Streptognathodus lateralis* conodont Zone. Two subzones are recognized for the Panching limestone, a lower *Idiognathoides noduliferus inaequalis*-*Gnathodus commutatus* Subzone and an upper *Idiognathoides noduliferus japonicus*-*Rhachistognathus* Subzone. The age of the faunas in terms of European Stages is Chokierian (H_1) and possibly Alportian (H_2). It is considered that the Mississippian-Pennsylvanian boundary may be correlated with a level in the Panching limestone.

THE Panching limestone (a term here used informally pending formal designation; Metcalfe, Idris, and Tan, in prep.) crops out as a narrow band running SSW.-NNE. in the Panching area approximately twenty miles north-west of Kuantan, Pahang, West Malaysia (text-fig. 1). The



TEXT-FIG. 1. Sketch-map of the area west of Kuantan, Pahang, West Malaysia, showing the location of the Panching limestone.



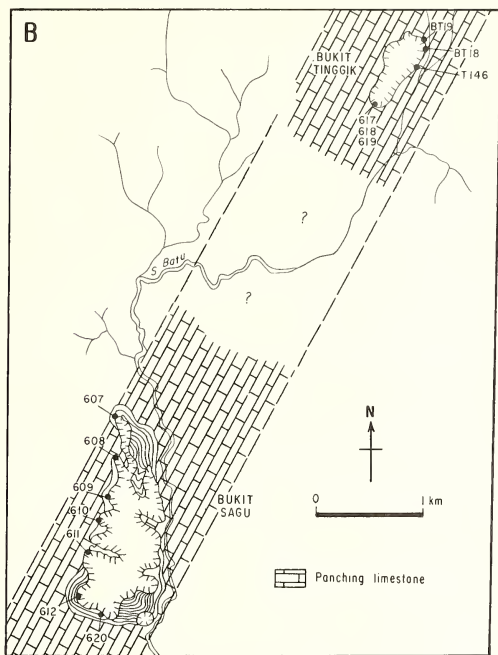
TEXT-FIG. 2A. Sketch-map showing sample localities at Bukit Panching and Bukit Charas.

limestone, which is 600 m thick, conformably overlies a series of alternating shales and sandstones approximately 1500 m thick, here referred to as Charu beds, and is overlain by alternating conglomerates, shales, and sandstones approximately 1600 m thick, here termed the Sagor beds. These sediments, which constitute the 'Kuantan Group' of Alexander (1959), generally dip steeply south-eastwards, but are tightly folded in many places.

Exposures of the Panching limestone, which is massive, fossiliferous, and partly recrystallized, occur as isolated limestone hills, which rise steeply out of relatively flat land to approximately 250 m. There are four limestone hills, which are from south to north, Bukit Panching, Bukit Charas, Bukit Sagu, and Bukit Tinggik. Samples were collected from each of the hills, and text-fig. 2 gives the locations of samples, which were all collected at ground level.

The age of the Panching limestone was originally regarded as Viséan (Muir-Wood *et al.* 1948; Fitch 1951; Sakagami 1972; Ozawa 1975). Igo and Koike (1968) and Mamet and Saurin (1970), however, described conodonts and foraminifera from Bukit Charas which they considered to be Namurian in age. Igo and Koike (1968) recorded *Idiognathoides noduliferus*, *Gnathodus bilineatus*, *Spathognathodus campbelli*, *Ozarkodina* sp., and *Hindeodella* sp. from Bukit Charas. The present study was undertaken to extract a more varied conodont fauna and to date the limestone more precisely in terms of conodont biostratigraphy.

TEXT-FIG. 2b. Sketch-map showing sample localities at Bukit Sagu and Bukit Tinggi.



SYSTEMATIC PALAEOZOOLOGY

All figured specimens are deposited in the Department of Geology, University of Malaya.

Genus *Apatognathus* Branson and Mehl, 1934

Type species: *Apatognathus varians* Branson and Mehl, 1934

Apatognathus cuspidatus Varker

Plate 37, fig. 1

1967 *Apatognathus?* *cuspidata* Varker, p. 131, pl. 17, figs. 4, 6-10.

1970 *Apatognathus?* *cuspidatus* Varker; Reynolds, p. 7, pl. iii, fig. 4.

Remarks. The specimen is unfortunately broken but possesses the characteristic apical denticle of *A. cuspidatus*.

Material. 1 specimen, figured A339.

Apatognathus libratus Varker

Plate 37, fig. 4

- 1967 *Apatognathus? librata* Varker, p. 134, pl. 18, figs. 3, 6, 8, 9, 12, 13.
 1969 *Apatognathus* cf. *libratus* Varker; Rhodes, Austin and Druce, p. 75, pl. 20, fig. 8a, b.
 1970 *Apatognathus? libratus* Varker; Reynolds, p. 7, pl. iii, fig. 2.
 1974 *Apatognathus libratus* Varker; Austin and Husri, pl. 10, fig. 6a, b.

Material. 1 specimen, figured A340.

Apatognathus scalenus Varker

Plate 37, fig. 2

- 1967 *Apatognathus? scalena* Varker, p. 136, pl. 18, figs. 1, 2, 4, 5.
 1969 *Apatognathus scalenus* Varker; Rhodes, Austin and Druce, p. 74, pl. 20, figs. 9a-11b (with synonymy).
 1970 *Apatognathus? scalenus* Varker; Reynolds, p. 7, pl. iii, fig. 6.
 1974 *Apatognathus scalenus* Varker; Austin and Husri, pl. 10, fig. 12a, b.

Remarks. The present specimen has a more pronounced inward curvature of the apical denticle than is normal in *A. scalenus*, but this is not considered of specific significance.

Material. 1 specimen, figured A341.

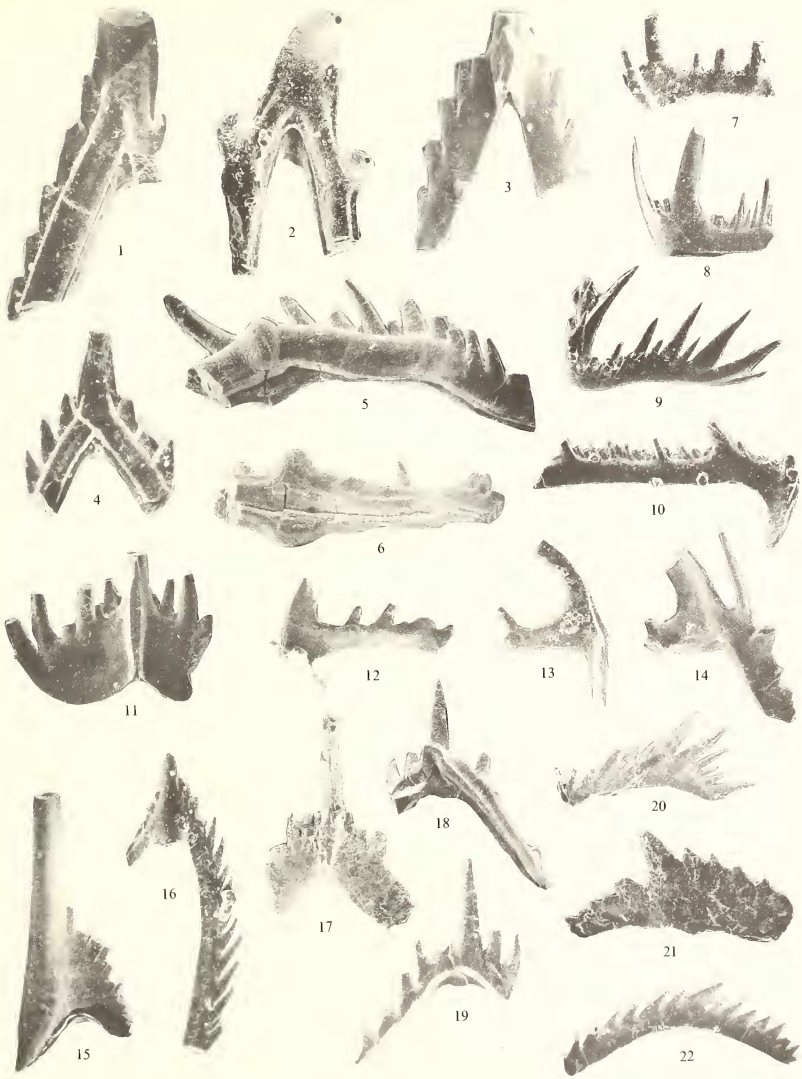
Genus *Geniculatus* Hass, 1953

Type species: *Polygnathus? claviger* Roundy, 1926

EXPLANATION OF PLATE 37

All figures are scanning electron micrographs.

- Fig. 1. *Apatognathus cuspidatus* Varker, inner lateral view of A339, sample 579, $\times 120$.
 Fig. 2. *Apatognathus scalenus* Varker, inner lateral view of A341, sample 614, $\times 100$.
 Fig. 3. *Hibbardella acuta* Murray and Chronic, posterior view of A352, sample 588, $\times 100$.
 Fig. 4. *Apatognathus libratus* Varker, inner lateral view of A340, sample 579, $\times 120$.
 Figs. 5, 6. *Geniculatus claviger* (Roundy). 5. inner lateral view of A342, sample 588, $\times 100$. 6. aboral view of A342, $\times 100$.
 Fig. 7. *Hindeodella undata* Branson and Mehl, lateral view of A355, sample 588, $\times 60$.
 Fig. 8. *Hindeodella mehli* Elias, lateral view of A356, sample 588, $\times 60$.
 Fig. 9. *Hindeodella uncata* Hass, oral view of A357, sample 610, $\times 100$.
 Fig. 10. *Hindeodella ibergensis* Bischoff, lateral view of A384, sample 585, $\times 100$.
 Fig. 11. *Hibbardella pemata* Higgins, posterior view of A353, sample 588, $\times 120$.
 Fig. 12. *Ligonodina roundyi* Hass, lateral view of A366, sample 588, $\times 60$.
 Figs. 13, 14. *Lonchodina bischoffi* Higgins and Bouckaert. 13. inner lateral view of A367, sample 588, $\times 60$.
 14. inner lateral view of A368, sample 588, $\times 50$.
 Fig. 15. *Neoprioniodus singularis* (Hass), inner lateral view of A370, sample 588, $\times 60$.
 Fig. 16. *Synprioniodina microdenta* Ellison, lateral view of A381, sample 585, $\times 100$.
 Fig. 17. *Hibbardella geniculata* Higgins, posterior view of A354, sample 578, $\times 100$.
 Figs. 18, 19. *Lonchodina ponderosa* Ellison. 18. aboral view of A369, sample 580, $\times 50$. 19. oral view of A369.
 Fig. 20. *Subbryantodus subaequalis* Higgins, lateral view of A380, sample 588, $\times 60$.
 Fig. 21. *Ozarkodina* sp., lateral view of A373, sample 578, $\times 100$.
 Fig. 22. *Ozarkodina delicatula* (Stauffer and Plummer), lateral view of A371, sample 579, $\times 50$.



METCALFE, Carboniferous conodonts

Geniculatus claviger (Roundy)

Plate 37, figs. 5, 6

- 1926 *Polygnathus? claviger* Roundy, p. 14, pl. 4, figs. 1a-c, 2a-b.
 1926 *Prioniodus* sp. D Roundy (partim), p. 11, pl. 4, fig. 13a-b.
 1926 *Prioniodus healdi* Roundy, p. 10, pl. 4, fig. 5a-b.
 1975 *Geniculatus claviger* (Roundy) Higgins, p. 27, pl. 2, fig. 5 (with synonymy).

Material. 4 specimens, figured A342.

Genus *Gnathodus* Pander, 1856

Type species: *Gnathodus mosquensis* Pander, 1856

Gnathodus bilineatus (Roundy)

Plate 38, figs. 5, 8, 9

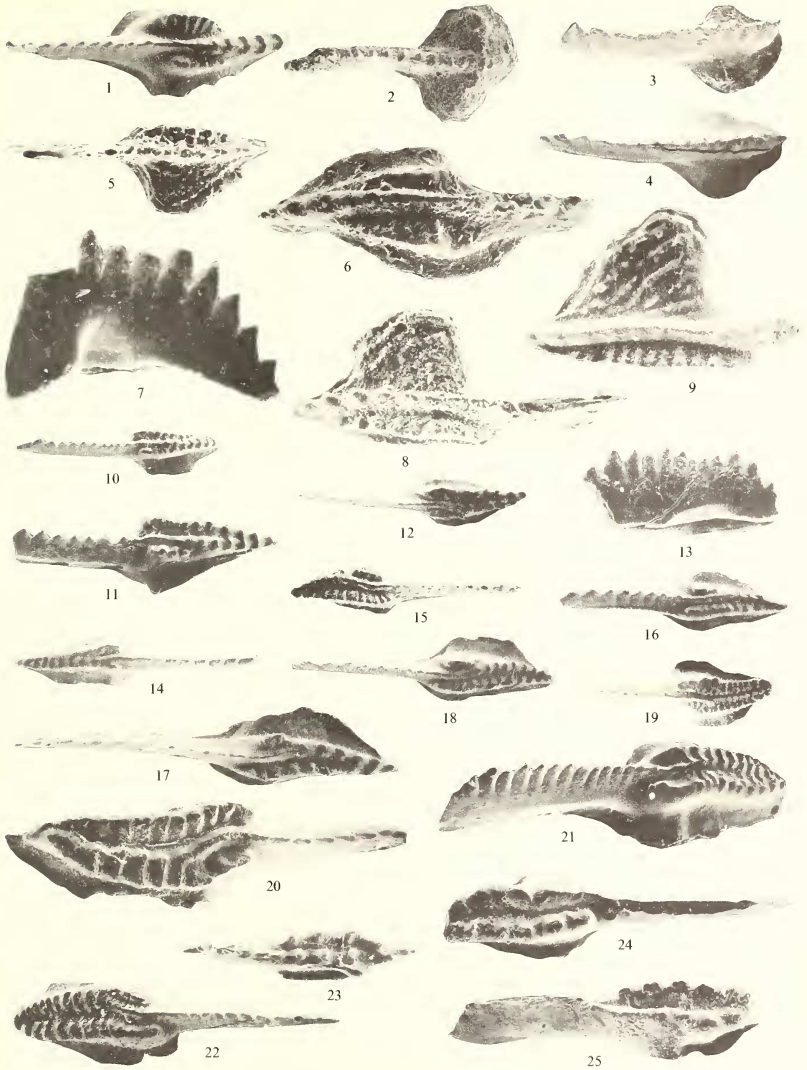
- 1926 *Polygnathus bilineatus* Roundy, p. 13, pl. 3, fig. 10a-c.
 1974 *Gnathodus bilineatus* (Roundy) Lane and Straka, pp. 72-77, fig. 32: 1-5, 7, 9, 11-13; fig. 33: 11-13, 19-23, 25, 28-32; fig. 34: 10, 13-26; fig. 40: 27 (with synonymy).
 1975 *Gnathodus bilineatus bilineatus* (Roundy) Higgins, p. 28, pl. 11, figs. 1-4, 6, 7 (with synonymy).
 1975 *Gnathodus bilineatus bollandensis* Higgins and Bouckaert; Higgins, p. 29, pl. 11, figs. 5, 8-13 (with synonymy).

Material. 18 specimens, figured A343, A344, A345.

EXPLANATION OF PLATE 38

All figures are scanning electron micrographs.

- Fig. 1. *Gnathodus girtyi simplex* Dunn, oral view of A350, sample 610, $\times 50$.
 Fig. 2. *Gnathodus nodosus* (Bischoff), oral view of A351, sample 577, $\times 50$.
 Figs. 3, 4. *Gnathodus commutatus* (Branson and Mehl). 3. oral view of A347, sample 588, $\times 60$. 4. oral view of A346, sample 588, $\times 50$.
 Figs. 5, 8, 9. *Gnathodus bilineatus* (Roundy). 5. oral view of A344, sample 575, $\times 100$. 8. oral view of A343, sample 575, $\times 100$. 9. oral view of A345, sample 580, $\times 120$.
 Fig. 6. *Gnathodus girtyi rhodesi* Higgins, oral view of A349, sample 578, $\times 160$.
 Fig. 7. *Spathognathodus scitulus* (Hinde), lateral view of A375, sample 579, $\times 100$.
 Figs. 10, 11, 12, 15. *Idiognathoides noduliferus inaequalis* Higgins. 10. oral view of A360, sample 610, $\times 50$. 11. oral view of A358, sample 618, $\times 100$. 12. oral view of A361, sample 585, $\times 50$. 15. oral view of A359, sample 620, $\times 50$.
 Fig. 13. *Spathognathodus campbelli* Rexroad, lateral view of A374, sample 579, $\times 100$.
 Figs. 14, 17. *Idiognathoides noduliferus japonicus*. 14. oral view of A363, sample 586, $\times 50$. 17. oral view of A362, sample 586, $\times 100$.
 Figs. 16, 18. *Idiognathoides noduliferus noduliferus* (Ellison and Graves). 16. oral view of A364, sample 585, $\times 50$. 18. oral view of A365, sample 585, $\times 50$.
 Figs. 19-22. *Streptognathodus lateralis* Higgins and Bouckaert. 19. oral view of A379, sample 617, $\times 25$. 20. oral view of A377, sample 620, $\times 50$. 21. oblique oral view of A378, sample 618, $\times 50$. 22. oral view of A376, sample 620, $\times 50$.
 Fig. 23. *Rhachistognathus primus* Dunn, oral view of A383, sample 585, $\times 100$.
 Figs. 24, 25. *Rhachistognathus muricatus* (Dunn). 24. oral view of A382, sample 620, $\times 50$. 25. outer lateral view of A382.



METCALFE, Carboniferous conodonts

Gnathodus commutatus (Branson and Mehl)

Plate 38, figs. 3, 4

1941 *Spathognathodus commutatus* Branson and Mehl, p. 98, pl. 19, figs. 1-4.1975 *Paragnathodus commutatus* (Branson and Mehl) Higgins, p. 70, pl. 7, figs. 7-9, 11, 13, 16, 20, 21 (with synonymy).*Material.* 21 specimens, figured A346, A347.*Gnathodus girtyi rhodesi* Higgins

Plate 38, fig. 6

1975 *Gnathodus girtyi rhodesi* Higgins, p. 32, pl. 10, figs. 3, 4 (with synonymy).*Material.* 3 specimens, figured A349.*Gnathodus girtyi simplex* Dunn

Plate 38, fig. 1

1965 *Gnathodus girtyi simplex* Dunn, p. 1158, pl. 140, figs. 2, 3, 12.1975 *Gnathodus girtyi simplex* Dunn; Higgins, p. 33, pl. 10, figs. 3, 4 (with synonymy).*Remarks.* *G. girtyi simplex* has been recorded from the Mississippian and basal Pennsylvanian of the U.S.A. (Lane and Straka 1974) and from the Pendleian and Arnsbergian Stages of Britain (Higgins 1975). This subspecies was considered by Dunn (1970a) to be the ancestor of *Idiognathoides noduliferus*.*Material.* 2 specimens, figured A350.*Gnathodus nodosus* (Bischoff)

Plate 38, fig. 2

1957 *Gnathodus commutatus nodosus* Bischoff, p. 23, pl. 4, figs. 12, 13.1960 *Gnathodus cruciformis* Clarke, p. 25, pl. iv, figs. 10-12.1969 *Gnathodus mononodosus* Rhodes, Austin and Druce, p. 103, pl. 19, figs. 13a-15d.1975 *Paragnathodus cruciformis* (Clarke) Higgins, p. 71, pl. 7, fig. 10.1975 *Paragnathodus mononodosus* (Rhodes, Austin and Druce) Higgins, p. 71, pl. 7, fig. 14 (with synonymy).1975 *Paragnathodus nodosus* (Bischoff) Higgins, p. 72, pl. 7, figs. 12, 15, 17-19, 22, 23 (with synonymy).*Material.* 3 specimens, figured A351.Genus *Hibbardella* Ulrich and BasslerType species: *Prioniodus angulatus* Hinde, 1879*Hibbardella acuta* Murray and Chronic

Plate 37, fig. 3

For synonymy and description see Higgins (1975, p. 34).

Material. 4 specimens, figured A352.

Hibbardella geniculata Higgins

Plate 37, fig. 17

1975 *Hibbardella geniculata* Higgins, p. 35, pl. 6, figs. 11, 12, 14.*Material.* 1 specimen, figured A354.*Hibbardella pennata* Higgins

Plate 37, fig. 11

For synonymy see Higgins (1975, p. 36) and description Higgins (1961, p. 213).

Material. 6 specimens, figured A353.Genus *Hindeodella* Ulrich and Bassler, 1926Type species: *Hindeodella subtilis* Ulrich and Bassler, 1926*Hindeodella ibergensis* Bischoff

Plate 37, fig. 10

For synonymy see Higgins (1975, p. 38).

Material. 18 specimens, figured A384.*Hindeodella mehli* Elias

Plate 37, fig. 8

1942 *Lochreia montanaensis* Scott (partim), pl. 39, fig. 7; pl. 40, fig. 18.1956 *Hindeodella bigeniculata* Elias (partim), p. 106, pl. 1, figs. 20, 21.1956 *Hindeodella mehli* Elias, p. 108, pl. 1, figs. 22-24.1957 *Hindeodella germana* Holmes; Bischoff (partim), p. 27, pl. 6, fig. 32.1958 *Hindeodella montanaensis* (Scott) Stanley (partim), p. 465, pl. 64, figs. 1-5.1961 *Hindeodella germana* Holmes; Higgins (partim), pl. 10, fig. 12.1968 *Hindeodella germana* Holmes; Higgins and Bouckaert, p. 36, pl. 1, fig. 12.1969 *Hindeodella montanaensis* (Scott) Rhodes, Austin and Druce, p. 123, pl. 28, figs. 21, 26.1974 *Hindeodella montanaensis* (Scott) Austin and Husri, pl. 15, fig. 16.1975 *Hindeodella germana* Holmes; Higgins, p. 38, pl. 5, fig. 6.

Remarks. Scott (1942) described this form species as part of the multi-element species *Lochreia montanaensis*. It is considered inappropriate to use the multi-element specific name for the form species, and therefore the next unambiguous name available (i.e. *H. mehli* Elias, 1956) is used.

Material. 3 specimens, figured A356.*Hindeodella uncata* Hass

Plate 37, fig. 9

For synonymy see Higgins (1975, p. 44).

Material. 1 specimen, figured A357.

Hindeodella undata Branson and Mehl

Plate 37, fig. 7

For synonymy see Higgins (1975, p. 44).

Material. 1 specimen, figured A355.Genus *Idiognathoides* Harris and Hollingsworth, 1933Type species: *Idiognathoides sinuatus* Harris and Hollingsworth, 1933*Idiognathoides noduliferus* Group

In this paper, the subdivision of *I. noduliferus* into three subspecies, *I. noduliferus inaequalis*, *I. noduliferus noduliferus*, and *I. noduliferus japonicus* made by Higgins (1975) is followed. Higgins (1975, p. 52) showed that these three subspecies form a transition series by reduction of the outer lateral platform.

Idiognathoides noduliferus inaequalis Higgins

Plate 38, figs. 10, 11, 12, 15

- 1975 *Idiognathoides noduliferus inaequalis* Higgins, p. 53, pl. 12, figs. 1-7, 12; pl. 14, figs. 11-13; pl. 15, figs. 10, 14.

Remarks. This subspecies is recognized by having four or more nodes developed on the outer platform.

Material. 211 specimens, figured A358-A361.*Idiognathoides noduliferus japonicus* (Igo and Koike)

Plate 38, figs. 14, 17

- 1964 *Streptognathodus japonicus* Igo and Koike, p. 188, pl. 28, figs. 5-10.
1975 *Idiognathoides noduliferus japonicus* (Igo and Koike) Higgins, p. 54, pl. 14, figs. 7-10 (with synonymy).

Remarks. This subspecies is characterized by having only a single node on its outer platform.

Material. 13 specimens, figured A362, A363.*Idiognathoides noduliferus noduliferus* (Ellison and Graves)

Plate 38, figs. 16, 18

- 1941 *Cavusgnathus noduliferus* Ellison and Graves, p. 4, pl. 3, fig. 4.
1974 *Idiognathoides noduliferus* (Ellison and Graves) Lane and Straka, p. 85, fig. 35: 1-15, fig. 41: 15-17.
1975 *Idiognathoides noduliferus noduliferus* (Ellison and Graves) Higgins, p. 54, pl. 14, figs. 15, 16 (with synonymy).

Remarks. This subspecies is characterized by having two or three nodes developed on its outer platform.

Material. 75 specimens, figured A364, A365.

Genus *Ligonodina* Ulrich and Bassler, 1926

Type species: *Ligonodina pectinata* Ulrich and Bassler 1926

Ligonodina roundyi Hass

Plate 37, fig. 12

For synonymy see Higgins (1975, p. 58).

Material. 1 specimen, figured A366.

Genus *Lonchodina* Ulrich and Bassler, 1926

Type species: *Lonchodina typicalis* Ulrich and Bassler, 1926

Lonchodina bischoffi Higgins and Bouckaert

Plate 37, figs. 13, 14

1968 *Lonchodina bischoffi* Higgins and Bouckaert, p. 43.

1975 *Lonchodina bischoffi* Higgins and Bouckaert; Higgins, p. 59, pl. 2, figs. 1-4, 8 (with synonymy).

Material. 3 specimens, figured A367, A368.

Lonchodina ponderosa Ellison

Plate 38, figs. 18, 19

1941 *Lonchodina? ponderosa* Ellison, p. 116, pl. 20, figs. 37-39.

1975 *Lonchodina ponderosa* Ellison; Higgins, p. 60, pl. 2, fig. 11 (with description).

Material. 1 specimen, figured A369.

Genus *Neoprioniodus* Rhodes and Muller, 1956

Type species: *Prioniodus conjunctus* Gunnell, 1931

Neoprioniodus scitulus? (Branson and Mehl)

For synonymy see Rhodes, Austin and Druce (1969, p. 162).

Material. 2 fragmentary specimens.

Neoprioniodus singularis (Hass)

Plate 37, fig. 15

For synonymy see Thompson (1972, p. 37).

Material. 10 specimens, figured A370.

Genus *Ozarkodina* Branson and Mehl, 1933

Type species: *Ozarkodina typica* Branson and Mehl, 1933

Ozarkodina delicatula (Stauffer and Plummer)

Plate 37, fig. 22

For synonymy see Webster (1969) and Higgins (1975).

Material. 33 specimens, figured A371.*Ozarkodina* sp.

Plate 37, fig. 21

Remarks. The specimen illustrated resembles young forms of *O. delicatula* but is considered to be too large for a juvenile of that species.*Material.* 1 specimen, figured A373.Genus *Rhachistognathus* Dunn, 1966Type species: *Rhachistognathus primus* Dunn, 1966*Rhachistognathus muricatus* (Dunn)

Plate 38, figs. 24, 25

1965 *Cavusgnathus muricatus* Dunn, p. 1147, pl. 140, figs. 1, 4.1974 *Rhachistognathus muricatus* (Dunn) Lane and Straka, p. 97, fig. 35: 16, 17, 24, 30, 31 (with synonymy).*Remarks.* This species is similar to *Idiognathoides minutus* Higgins and Bouckaert, but Higgins (1975, p. 50) has pointed out that *I. minutus* is normally half the size of *R. muricatus*, and does not possess the medial row of nodes developed posteriorly in many specimens of *R. muricatus*.*Material.* 3 specimens, figured A382.*Rhachistognathus primus* Dunn

Plate 38, fig. 23

1966 *Rhachistognathus prima* Dunn, p. 1301, pl. 157, figs. 1, 2.1974 *Rhachistognathus primus* Dunn; Lane and Straka, p. 98, fig. 35: 18-23, 25-29, 32-40, fig. 44: 6 (with synonymy).*Remarks.* Lane and Straka (1974) have shown that *R. muricatus* and *R. primus* are intergradational via a transitional morphotype *R. transitorius*.*Material.* 1 specimen, figured A383.Genus *Spathognathodus* Branson and Mehl, 1941Type species: *Ctenognathus munchisoni* Pander, 1856.*Spathognathodus campbelli* Rexroad

Plate 38, fig. 13

1957 *Spathognathodus campbelli* Rexroad, p. 37, pl. 3, figs. 13-15.1975 *Spathognathodus campbelli* Rexroad; Higgins, p. 73, pl. 10, fig. 11 (with synonymy).

Remarks. This is a somewhat variable species. The denticles of the unit may be sub-equal or may be larger in the anterior half. The lateral oral outline may be straight, or in some specimens considerably convex. In oral view the unit varies from straight to bowed.

Material. 7 specimens, figured A374.

Genus *Streptognathodus* Stauffer and Plummer, 1932

Type species: *Streptognathodus excelsus* Stauffer and Plummer, 1932.

Streptognathodus lateralis Higgins and Bouckaert

Plate 38, figs. 19-22

1968 *Streptognathodus lateralis* Higgins and Bouckaert, p. 45, pl. 5, figs. 1-4, 7.

1975 *Streptognathodus lateralis* Higgins and Bouckaert; Higgins, p. 73, pl. 12, fig. 9; pl. 17, figs. 10, 11, 13, 14 (with synonymy).

Material. 25 specimens, figured A376-A379.

Genus *Subbryantodus* Branson and Mehl, 1934

Type species: *Subbryantodus arcuatus* Branson and Mehl, 1934.

Subbryantodus subaequalis Higgins

Plate 37, fig. 20

For synonymy see Higgins (1975, p. 74) and description Higgins (1961, p. 218).

Material. 4 specimens, figured A380.

Genus *Synprioniodina* Ulrich and Bassler, 1926

Type species: *Synprioniodina alternata* Ulrich and Bassler, 1926

Synprioniodina microdenta Ellison

Plate 37, fig. 16

For synonymy and description see Higgins (1975, p. 75).

Material. 8 specimens, figured A381.

CONODONT ZONATION

The ranges of conodont species in the Panching limestone are given in text-fig. 3 and the numerical distribution in individual samples in Table 1. The Panching limestone fauna contains an assemblage characteristic of Higgins's (1975) *Idiognathoides noduliferous* Subzone and is therefore referred to the *I. noduliferus*-*Streptognathodus lateralis* Zone. In the Panching limestone, a lower and an upper fauna are recognized and these are here designated subzones. The lower subzone, the *I. noduliferus inaequalis*-*Gnathodus commutatus* Subzone, is taken to have its lower limit defined by the first appearance of *I. noduliferus inaequalis* and or *I. noduliferus noduliferus* and its upper limit defined as the first appearance of *I. noduliferus japonicus*. This subzone is characterized by an association of gnathodids and idiognathoidids, and in particular an association of *G. bilineatus*, *I. noduliferus inaequalis*, *I. noduliferus noduliferus*, and *G. commutatus*. The upper subzone, the *I. noduliferus*

NAMURIAN		Series Stage
Chokierian	Alportian	
H ₁ b	P ¹ H ₂ a	European goniatite zones
		<i>Apatognathus cuspidatus</i>
		<i>Apatognathus libratus</i>
		<i>Apatognathus scalenus</i>
		<i>Geniculatus claviger</i>
		<i>Gnathodus bilineatus</i>
		<i>Gnathodus commutatus</i>
		<i>Gnathodus girtyi rhodesi</i>
		<i>Gnathodus girtyi simplex</i>
		<i>Gnathodus nodosus</i>
		<i>Hibbardella acuta</i>
		<i>Hibbardella geniculata</i>
		<i>Hibbardella pennata</i>
		<i>Hindeodella ibergensis</i>
		<i>Hindeodella mehli</i>
		<i>Hindeodella uncatata</i>
		<i>Hindeodella undata</i>
		<i>Idiognathoides noduliferus inaequalis</i>
		<i>Idiognathoides noduliferus japonicus</i>
		<i>Idiognathoides noduliferus noduliferus</i>
		<i>Kladognathus</i> sp.
		<i>Ligonodina roundyi</i>
		<i>Ligonodina</i> sp.
		<i>Lonchodina bischoffi</i>
		<i>Lonchodina ponderosa</i>
		<i>Neoproniodus scitulus</i> ?
		<i>Neoproniodus singularis</i>
		<i>Ozarkodina delicatula</i>
		<i>Rhachistognathus muricatus</i>
		<i>Rhachistognathus primus</i>
		<i>Spathognathodus campbelli</i>
		<i>Spathognathodus scitulus</i>
		<i>Streptognathodus lateralis</i>
		<i>Subbryantodus subaequalis</i>
		<i>Synprioniodina microdonta</i>
		SUB ZONES
<i>Gnathodus commutatus</i>	<i>Rhachistognathus</i>	
<i>Idiognathoides noduliferus inaequalis</i>	<i>Idiognathoides japonicus</i>	CONODONT ZONE
<i>Idiognathoides noduliferus</i>	<i>Idiognathoides noduliferus japonicus</i>	
<i>Idiognathoides noduliferus inaequalis</i> - <i>Gnathodus commutatus</i>	<i>Idiognathoides noduliferus japonicus</i> - <i>Rhachistognathus</i>	
<i>Idiognathoides noduliferus</i> - <i>Streptognathodus lateralis</i>		

TEXT-FIG. 3. Ranges of conodont species in the Panching limestone.

Series	European goniatite Zones	West Malaysia (This paper)		Britain (Higgins 1975)		Japan (Koike 1967, Igo <i>et al.</i> 1978)	Nevada, Utah (Dunn 1970)	Arkansas, Oklahoma (Lone and Stroko 1974)
		Zone	Subzones	Zone	Subzones	Zones	Zones	Zones
NAMURIAN	? H _{2a}		<i>Idiagnathoides</i> <i>noduliferus</i>			<i>Gnathodus</i> <i>bassleri</i> <i>bassleri</i>		<i>Rhachistagnathus</i> <i>primus</i>
	H _{1b}		<i>Idiagnathoides</i> <i>noduliferus</i> - <i>Rhachistagnathus</i>	<i>Idiagnathoides</i> <i>noduliferus</i> -	<i>Idiagnathoides</i> <i>noduliferus</i>		<i>Rhachistagnathus</i>	<i>Rhachistagnathus</i> <i>muricatus</i>
			<i>Streptagnathodus</i> <i>lateralis</i>	<i>Idiagnathoides</i> <i>noduliferus</i> <i>inaequalis</i> - <i>Gnathodus</i> <i>commutatus</i>	<i>Streptagnathodus</i> <i>lateralis</i>		<i>Gnathodus</i> <i>bilineatus</i> - <i>Idiagnathoides</i> <i>noduliferus</i>	<i>Gnathodus girtyi</i> <i>simplex</i>
	H _{1a}				<i>Idiagnathoides</i> <i>minutus</i>			

TEXT-FIG. 4. Comparisons of early Namurian conodont zonations.

spanning the interval from late Dinantian to early Westphalian, and in Belgium (Higgins and Bouckaert 1968). The faunas of the Panching limestone are similar to those assigned by Higgins to the *I. noduliferus*-*S. lateralis* Zone, which is equivalent to the E_{2c} to H_{2c} goniatite zones. The upper fauna lacks any of the typical Kinderscoutian forms recorded by Higgins and is characterized by *I. noduliferus japonicus* which first occurs in Higgins and Bouckaert's (1968, p. 21) 'upper' fauna of H_{1b} in Belgium, and in H_{2a} in northern England: it is therefore likely to be of Alportian and possibly late Chokierian age. The lower fauna lacks *I. minutus*, characteristic of the late Arnsbergian and early Chokierian of northern England, and is therefore likely to be of late Chokierian age (H_{1b}).

The lower fauna from the Panching limestone contains *Gnathodus* spp., which was not recorded by Higgins (1975) from levels above E_{2c} in northern England. *Gnathodus* spp., however, do occur in H_{1b} in Belgium (Higgins and Bouckaert 1968, p. 21), and Higgins (pers. comm. 1978) has reported *G. bilineatus bollandensis* from the Alportian (H₂) of north Staffordshire, England.

Correlation with Japan. Watanabe (in Igo *et al.* 1978, fig. 14) recognized four conodont zones for the Omi Limestone in central Japan, from oldest to youngest, the *G. bilineatus* Zone, *S. noduliferus* Zone, *S. expansus*-*S. suberectus* Zone, and *G. ronndyi*-*I. delicatus* Zone. The middle and upper part of Watanabe's *S. noduliferus* Zone corresponds to the lower part of the *Profusulinella* fusuline zone and is therefore younger than the Panching limestone which contains an *Eostaffella*-*Millerella* Zone fauna (Ozawa 1975). The conodont faunas of the Panching limestone must therefore correlate with the lower part of Watanabe's *S. noduliferus* Zone which corresponds to the limestone conglomerate horizon of the Omi Limestone.

Koike (1967) proposed seven conodont zones for the late Mississippian to early Pennsylvanian Atetsu Limestone of south-west Japan. These zones are being modified by Koike (pers. comm.). In his revised zonation, Koike will recognize a *G. bilineatus*-*I. noduliferus* Zone (= *G. bilineatus*-*G. nodulifera* Zone of Koike 1967) at the top of the Nagoe Formation and an *I. noduliferus* Zone (= lower part of the *G. wapanuckensis* Zone of Koike 1967) at the base of the succeeding Kodani Formation. The *G. bilineatus*-*I. noduliferus* Zone of the Atetsu Limestone is correlated with the *I. noduliferus inaequalis*-*G. commutatus* Subzone of the present work since they both have an